

TWO SUCCESSFUL ACTION PROGRAMS FOR DOSE REDUCTION IN DIAGNOSTIC RADIOLOGY

Richard E. Gross

Bureau of Radiological Health, Food and Drug Administration
Rockville, Maryland 20857

1. INTRODUCTION

A paper reviewed (in a rapporteur session) at the Third International Congress of the International Radiation Protection Association, at Washington, D.C., examined the health physicists' role in the health care environment, stressing their potential for effecting exposure reduction through close working relationships with other health and allied health professionals.(1) This paper reports on two programs that demonstrate the success of such an approach.

Diagnostic x-ray examinations include three separate tasks:

1. selection of the patient,
2. performance of the examination, and
3. interpretation of the results.

Of course, physicists can have their greatest impact by improving the performance of the examination. Selection of the patient and interpretation of a properly conducted examination are the responsibility of the physician or radiologist.

The two programs discussed here were developed to help radiation control agencies at the Federal, State, and local levels to efficiently manage their efforts to reduce unnecessary exposure from dental and breast x-ray examinations.

2. DENTAL EXPOSURE PROBLEM

In 1972 a pilot study was conducted to identify the causes of high exposure in dental radiology and to test an educational approach for reducing unnecessary exposure (2). Survey data were collected on 110 x-ray units (72 dental offices) selected at random. The data showed that many offices overexposed films and reduced developing time. About one-third of the offices used sight development instead of the recommended time-temperature processing technique. Dental consultants visited the offices 2 months after the surveys to present findings and demonstrate needed improvements in radiographic practice. In 1973, a followup survey was conducted to determine the effectiveness of the consultation visits. Mean exposure per film was 542 mR in 1972 and 340 mR in 1973. This reduction of approximately 38 percent indicates the effectiveness of an educational approach to achieve significant reduction in unnecessary radiation exposure.

3. THE DENTAL EXPOSURE NORMALIZATION TECHNIQUE (DENT) PROGRAM

This exposure reduction and quality assurance program was developed through a joint State/Federal effort (3). A health agency sends cards containing thermoluminescent dosimeters (TLD's) to all dental x-ray facilities within its jurisdiction. These dosimeters are exposed by the dentists and returned for analysis. Facilities that show excessive exposure are then visited to demonstrate the changes in exposure and processing necessary to produce diagnostic quality radiographs with minimum patient exposure.

4. RESULTS OF DENT

Currently, 37 Federal, State, and local radiation control agencies, responsible for about two-thirds of the dental machines in the U.S., use the DENT program. Twelve of these have completed followup visits in facilities showing excessive exposure. Data reported by nine of these agencies show that approximately 43 percent of the machines evaluated by TLD's were visited because of high exposures. As a result of the followup surveys, the nine radiation control agencies were able to achieve an average exposure reduction of 240 mR per film, or approximately 41 percent. Furthermore, the dentist who follows the surveyor's recommendations for exposing and processing the films will, in general, produce consistently good diagnostic radiographs. Recently the American Academy of Dental Radiology endorsed DENT as an effective exposure reduction and quality assurance program (4).

5. THE MAMMOGRAPHY EXPOSURE PROBLEMS

Several events led to our current concern with exposure from mammography. First was the public awareness of breast cancer after publicized mastectomies on public figures; and the subsequent increase in the use of mammography. Another event was a study of mammographic exposure levels and techniques in Eastern Pennsylvania (5).

Mammography facilities, including 45 hospitals, 23 private radiology, and 2 clinics, were surveyed during routine State compliance inspections. Low energy dosimeters were used to measure the exposure from a single cranio-caudal view, using the technique factors normally employed by the facility for a "medium-density, medium-sized" breast. Mean exposure for the various types of image receptors ranged from 1 to 24 R. Five facilities were apparently overexposing and underdeveloping films, with a resultant mean exposure of 39 R per film, and a high of 47 R. The study concluded that approximately three-fifths of the surveyed facilities had not optimized their mammographic procedures for the x-ray energies and for image receptor development utilized.

This study has brought to light two problems. One, in many cases the exposure per film is unnecessarily high and, two, even if the exposure appears acceptable, the image quality may not be optimal. The second problem is a big one and will require a major cooperative effort on the part of several categories of the health profession to solve. There is still considerable debate regarding the appropriate x-ray energy spectrum for a given image receptor and even regarding which structures in the breast must be visualized.

Using an approach similar to that of the DENT program, we are working to correct the first problem, that of reducing unnecessarily high exposures. Although mammography is more complicated than dental radiography because of difficulties in soft tissue visualization and the large variety of image receptors and x-ray generating equipment, we have demonstrated through pilot tests that a program similar to DENT will be productive when applied to mammography.

6. THE BENT PROGRAM

The BENT (Breast Exposure: Nationwide Trends) program is conducted in the same manner as DENT (6). By contacting and obtaining the support of the

local physicians through the radiological and other medical societies, their cooperation results in high response rates and return of the questionnaire and dosimeters. Once support is obtained, physicians are mailed a questionnaire which is used to identify facilities that conduct mammographic examinations. Those responding affirmatively are asked to identify the number of x-ray units used for mammography and answer some questions regarding the number and age of patients examined.

Then the health agency sends the dosimeter cards to those facilities that conduct mammography exams. The dosimeters are exposed and returned for analysis. Facilities that show either excessive exposures or abnormally low exposures are visited to further evaluate the x-ray unit and image processing system and recommend changes in the mammographic techniques as required.

7. RESULTS OF BENT

At the close of 1976 the BENT program initiated trials in 5 States. The results can be summarized as follows:

Preliminary BENT Data (4 States)

| | <u>All Image Receptors</u> | <u>Direct Exposure Film</u> | <u>Film/Screen Combinations</u> | <u>Xero- radiography</u> |
|----------------------|--------------------------------|---------------------------------|-------------------------------------|------------------------------|
| No. of units | 401 | 75 | 187 | 139 |
| Percent of units | 100 | 18 | 47 | 35 |
| Mean Exposure (R)* | 1.5 | 3.2 | 0.62 | 1.8 |
| Minimum Exposure (R) | 0.03 | 0.3 | 0.03 | 0.18 |
| Median Exposure (R) | 0.51 | 1.5 | 0.40 | 1.1 |
| Maximum Exposure (R) | 16.6 | 16.6 | 5.0 | 6.9 |

*Exposure is expressed as Roentgens free-in-air at the skin entrance site (6 cm. above the tabletop or equivalent plane) for a single cranio-caudal view.

Followup visits of those facilities with exposures near the minimum and maximum values are still being conducted. Typically, in those cases where the exposures were unusually high, some mistakes were being made with the technique which probably provided a darker than usual image or the exposure was high because of improper film processing, using a very low kVp (26 or less), or insufficient filtration in the x-ray beam. For those cases where the exposures were abnormally low, the radiologists tended to be unhappy with the images and in many cases the image quality was significantly improved by reducing the beam quality for film mammography or by increasing the exposure (for Xerox systems) to a somewhat more normal level.

As a result of the initial trials, the BENT program has been shown to be an effective method for identifying facilities that are using exposures that seem to be inappropriate for mammographic examinations. It results not only in a reduction of exposures that are too high, but also in an improvement of the image quality for those situations where the images might be inferior for the purpose of diagnosis of early breast cancer. The cooperation from the radiologists who have been visited in the program thus far has been encouraging and lead us to believe that the BENT program will be as successful as the DENT program.

8. CONCLUSIONS

This paper has reviewed two educational programs that have been successful in reducing significant amounts of unnecessary radiation in the conduct of diagnostic x-ray examinations. The widespread use of these programs will result in a significant reduction of exposure to the population, resulting in better health care. Efforts must continue on an even broader scale to identify the causes of unnecessary radiation exposure and then develop and implement solutions that will eliminate unproductive radiation exposure.

REFERENCES

1. Gross, R., M. Marks, M. Audet, and J. Benson. "The Role of the Health Physicists in Reducing Medical Radiation." Proceedings of the International Congress of the International Radiation Protection Association (3rd), held at Washington, D.C. on 9-14 September 1973. National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151.
2. Crabtree, C. L., O. N. Johnson, and J. Gibbs "Nashville Dental Project: An Educational Approach for Voluntary Improvement of Radiographic Practice." DHEW Publication (FDA) 76-8011, Supt. of Documents, GPO, Washington, D.C. 20402, 1975.
3. Division of Training and Medical Application "Dental Exposure Normalization Technique (DENT) Instruction Manual." Bureau of Radiological Health, Rockville, Md. 20852, 1975.
4. AADR Newsletter, Vol. 3, No. 4, September 1976, Medical College of Georgia, Augusta, Georgia 30902.
5. Bicehouse, H. J. "Survey of Mammographic Exposure Levels and Techniques Used in Eastern Pennsylvania." Proceedings of the Seventh Annual National Conference on Radiation Control-Assuring Radiation Protection, pp. 136-143. Superintendent of Documents, U.S. GPO, Washington, D.C. 20402, February 1976.
6. Jans, R., et al. "Pilot Tests of a Mammography Quality Assurance Program." Presented at Health Physics Society Annual Meeting, San Francisco, California, June 27-July 2, 1976.